بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of graduate studies

Technical study of

Effect of Ambient Air Temperature on the Performance Factor of a Combined Cycle in

Garri Power Plant

تأثير درجة حرارة الجو فى معامل أداء الدورة المزدوجة

فى محطة كهرباء قرى للتوليد

This is submitted on partial fulfillment of the requirements for the degree of Master of Science in mechanical engineering

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Dedecation

To my:

Parents,

Wife & Son,

Family & Relative

To my:

Teachers,

Master group &

Friends

Abstract

The Combined cycle (Gas/Steam) Performance is highly sensitive to the Ambient Air temperature. Sudan is one of the countries which have high ambient air temperature and low humidity. As a result, power output from combined cycle decreases and the specific fuel consumption increases. When there is high power demand needed especially during summer season and the high price of fuel (light diesel oil).This problems can be avoided by cooling compressor inlet air temperature.

By application of media cooling system (evaporative) in Garri Combined cycle. The ambient air temperature decreased 38% for Gt7 & 31% for Gt8.

The performance test result show that the Compressor Specific work decreased by 1.15% for Gt7 & 2.9% for Gt8, Specific Net work increased by 1.15% for Gt7 & 2.9 for Gt8, power output increased by 11% for Gt7 & 8.8% for Gt8, Specific fuel consumption decreased by 1.8% for Gt7 & 3.3%

for Gt8, Fuel saving equal 0.22% forGt7 & 0.29% for Gt8, Gas turbine Efficiency increased by 0.62% for Gt7 & 0.92% for Gt8, Exhaust flow rate increased by 7.9%, Steam turbine pressure increased by 4.5%, Steam turbine power output increased by 2.2%, and Combined cycle Efficiency increased by 0.06%.

ملخص البحث

معامل أداء الدورة المزدوجة (غازية\بخارية) يتأثر بدرجة حرارة الجوالمحيط والسودان يعتبر من الدول ذات الحرارة العالية والرطوبة المنخفضة. نتيجة لهذة العوامل تنخفض القدرة المولدة من الدورة المزدوجة ويزداد الاستهلاك النوعى للوقود . عندما يكون هنالك طلب عالى للقدرة خصوصا فى فصل الصيف وايضا أسعار الوقود العالية (الجازولين)ز هذة المشكلة يمكن حلها بواسطة تبريد درجة حرارة الهواء الداخل للضاغط.

بواسطة تطبيق نظام التبريد (التبخيرى) فى محطة قرى المزدوجة . انخفضة درجة حرارة الجو المحيط 38% للتوربين الغازى نمرة 7 و 31% للتوربين الغازى نمرة 8

نتيجة تطبيق هذا النظام على معامل أداء الدورة المزدوجة كانت على النحو التالى

معامل أداء الدورة التوربين الغازى التوربين البخارى

المزدوجة	نمرة 7	نمرة 8	
انخفاض الشغل النوعى للضاغط	1.15 %	2.9 %	-
زيادة صافى الشغل النوعى	1.15 %	2.9 %	-
زيادة القدرة المولدة	11 %	8.8 %	2.2 %
زيادة الكفاءة	0.62 %	0.92 %	0.06 %
انخفاض الاستهلاك النوعى للوقود	1.8 %	3.3 %	-
توفير الوقود	0.22 %	0.29 %	-
زيادة معدل تدفق الغازات	10.6 %	5.5 %	7.9 %
زيادة ضغط البخار الداخل للتوربين	-	-	4.5 %

Contents

Chapter 1

Introduction

Chapter 2

Heat Recovery Steam Generation

Chapter 3

Gas turbine Inlet Air Cooling systems

Chapter 4

The Effect of Ambient Air Temperature on the Performance of Combined Cycle

Analysis

List of symbols

Symbol	Denotation	Unit
HRSG	Heat recovery steam generation	-
SGIP	Simple gas /steam combined cycle with single pressure	-

SG2PR	simple gas /steam combined cycle with dual pressure HRSG with reheating of steam	-
CG3PR	Complex gas (simple + intercooling + reheat) with triple pressure HRSG with reheating of steam	-
H	Higher or topping cycle	
L	lower or bottoming cycle	
Q	Heat	kJ
W	Work	kJ
QHR	Rejects heat to a lower or bottoming cycle	kJ
Qun	Unused to the surroundings	kJ
η	The thermal efficiency	
Bun	the ratio of unused heat Qun to the heat supplied QH	
η ccp	The thermal efficiency of combined cycle plant	
ηBoiler	Boiler efficiency	
GT	Gas turbine	
St	Steam turbine	
Rp	Pressure Ratio	
AR	Air rate	kg/s
ma	mass of air	kg
Sfc	Specific Fuel Consumption	kg/kWh

List of figures